



Photon Detection System Simulations Utilizing Geant4 and GATE

Kyle Spurgeon
Syracuse University
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- Motivations
- The simulation- Geant4 and GATE
- Simulation verification
- Present and future directions



Motivations

- DUNE
 - Model and compare PDS designs



The Simulation

- GATE
 - Designed for Medical Physics
 - Easy, built-in visualization
 - Simplified syntax
 - Built-in photon processes
 - Built on Geant4- can be overwritten by pure Geant4
- Geant4
 - Detector simulation package
 - All necessary processes built in

The Simulation

- Create necessary materials
 - Input data for EJ280, TPB, other substances
- Create and tune surface interfaces
- Implementation of physical characteristics
- Design test geometries

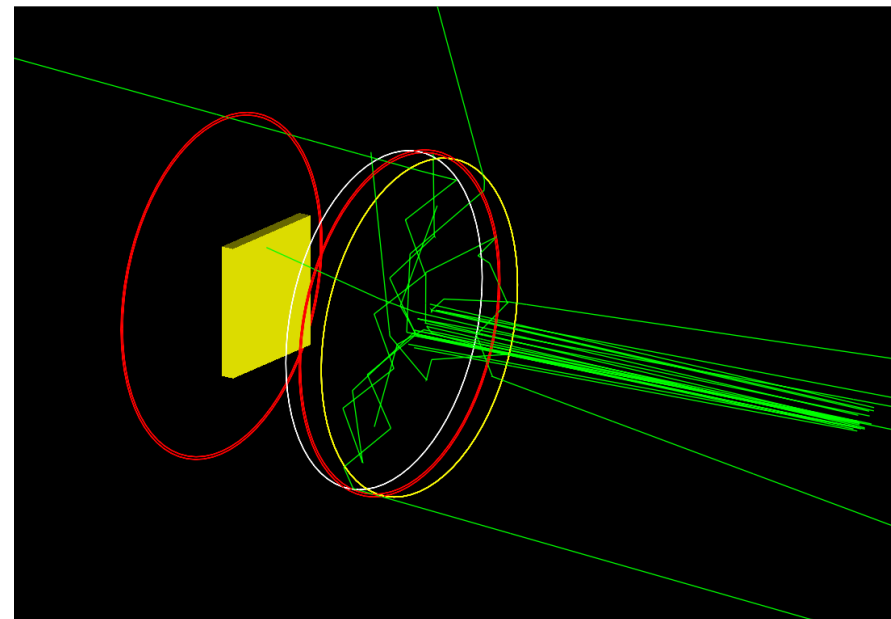


Verification

- Test newly created TPB layer properties
 - Compare to work done by Chris Benson (UC Berkeley)
 - Comparison of photon efficiencies vs TPB layer thickness
- Test EJ-280 physical characteristics
 - Compare to work done by Bruce Howard, et al at IU
 - Test attenuation length data

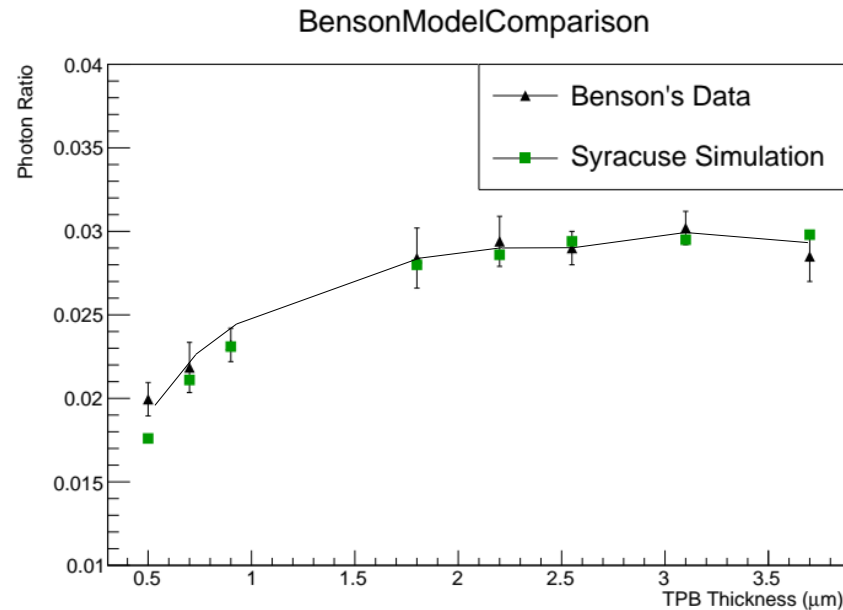
Verification

- Chris Benson's simulation geometry
- RAT simulation of experimental monochrometer setup
- Single acrylic disk with TPB layer



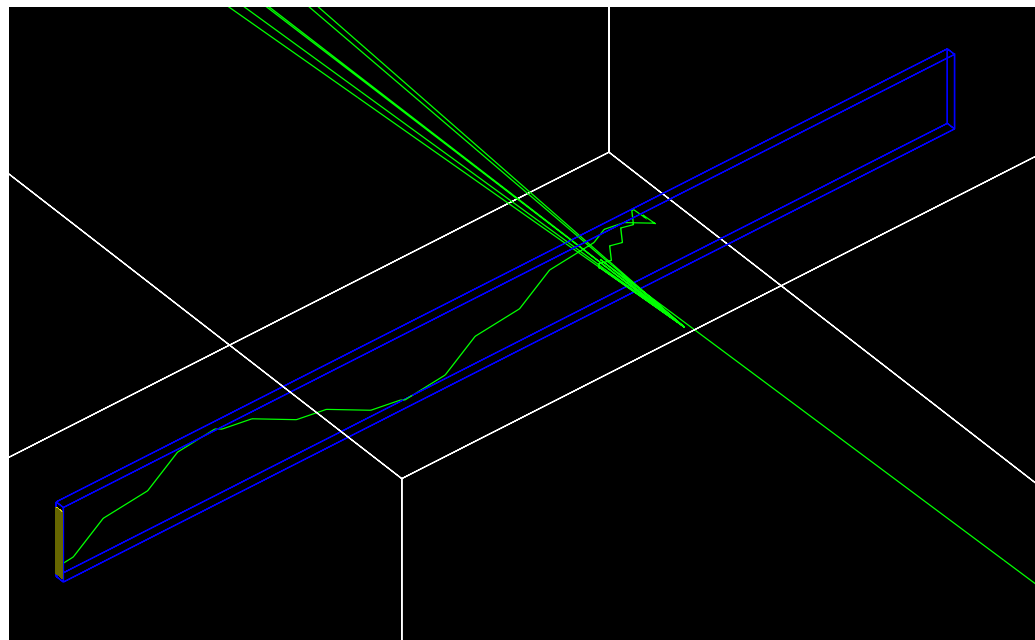
Verification

- Chris Benson's experimental data comparison
- Simulation designed based on experimental factors quoted in paper
- Chris's simulation trend shown



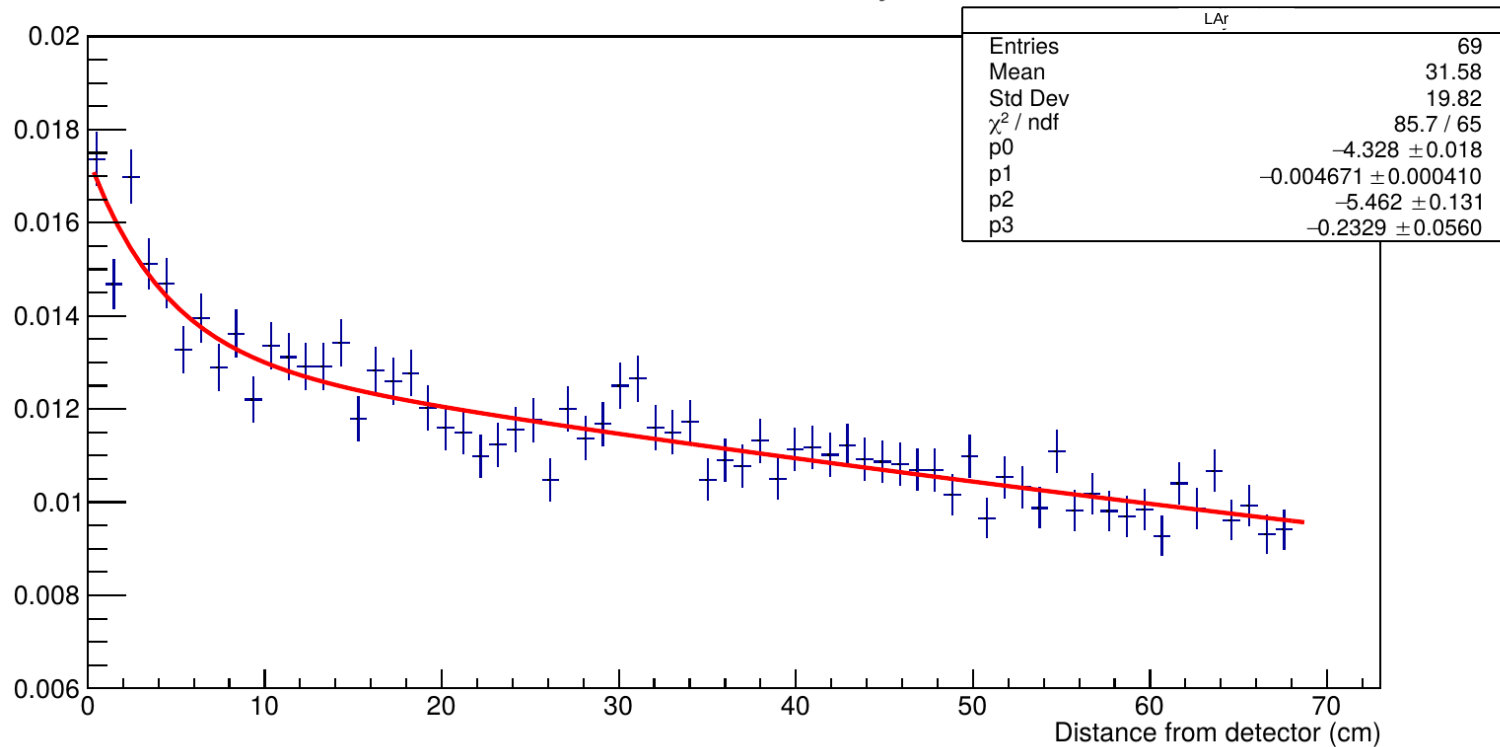
Verification

- Attenuation Lengths
 - Air: 5.92m
 - LAr Long: 214 cm
 - LAr Short: 4.29 cm
- Data:
 - Air: 6+ m
 - LAr Long: 225 cm
 - LAr Short: 4.3 cm



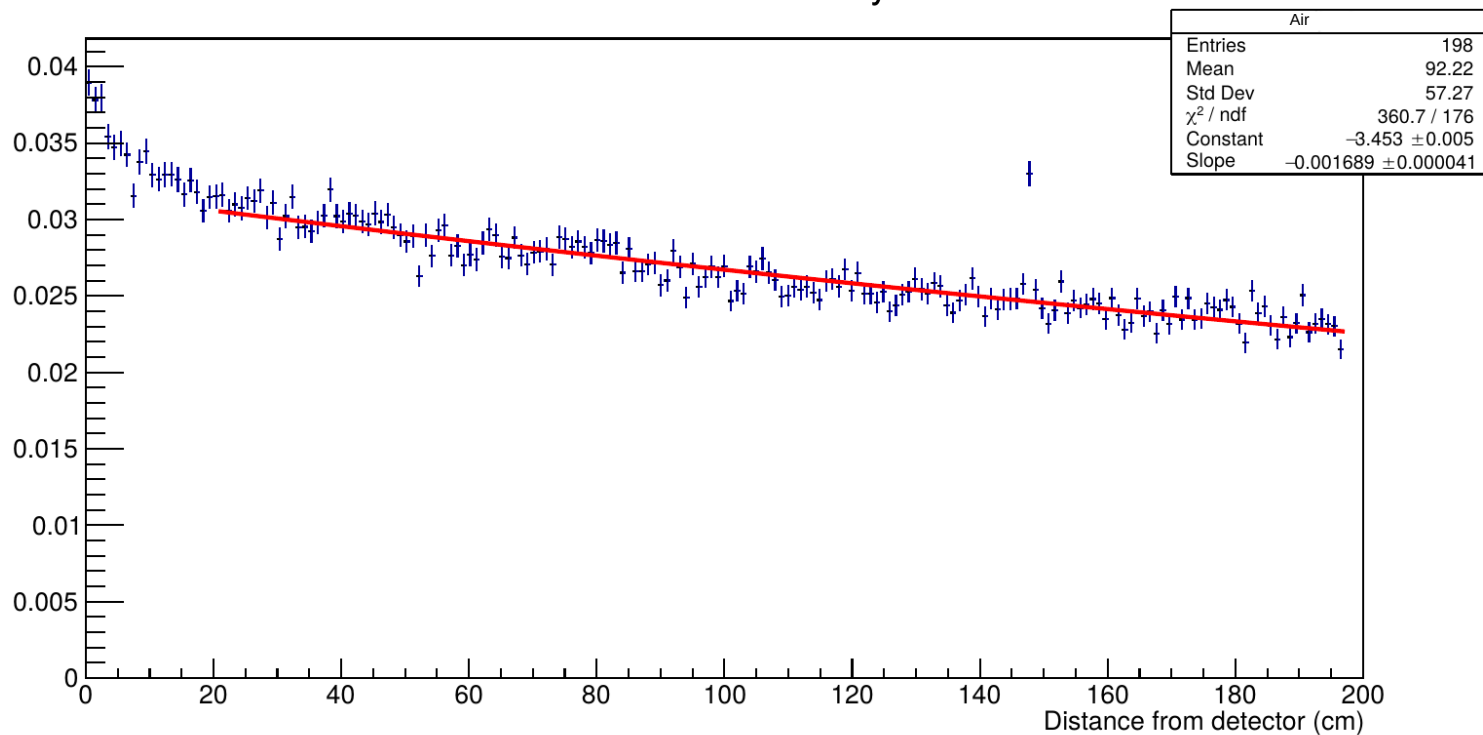
Verification

Detection Efficiency



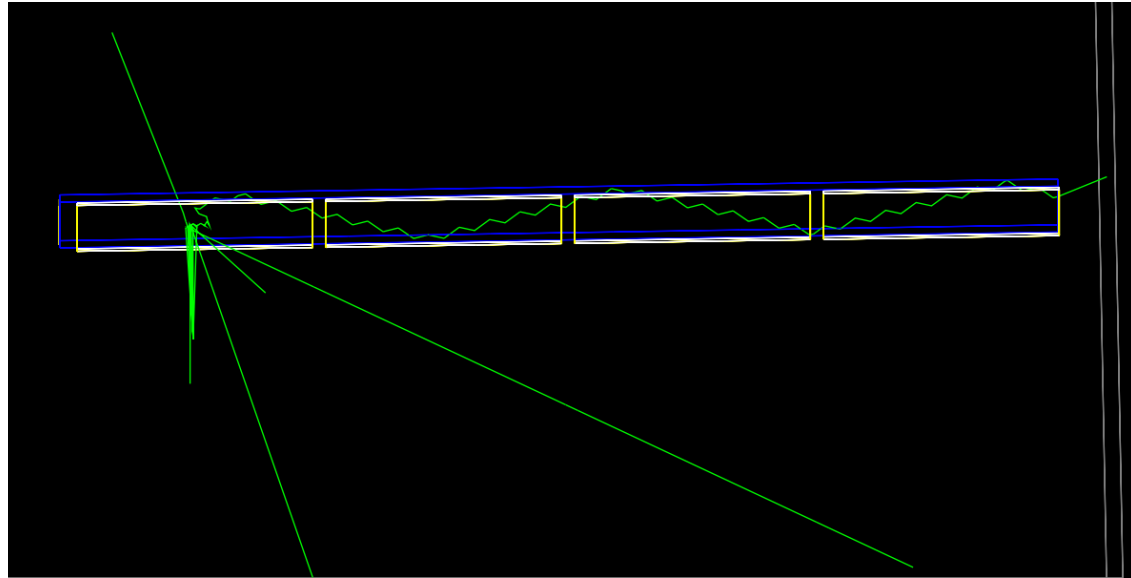
Verification

Detection Efficiency



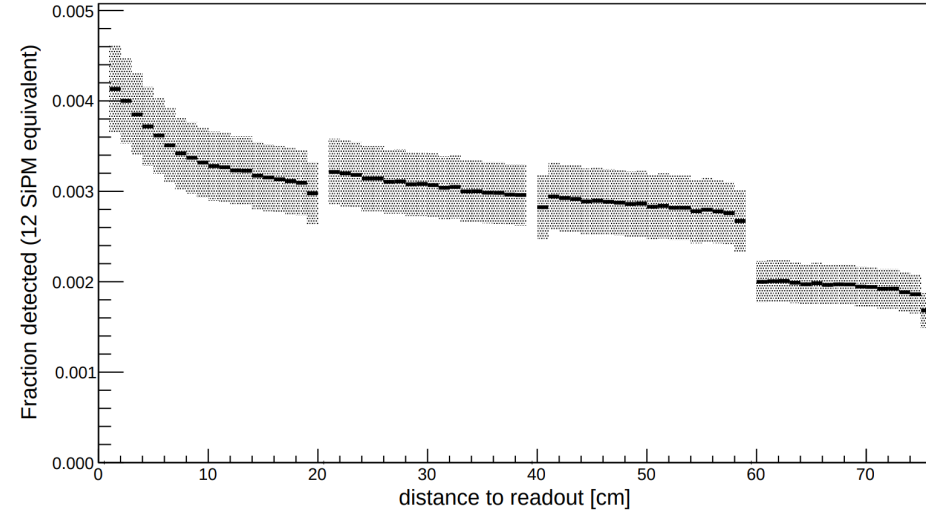
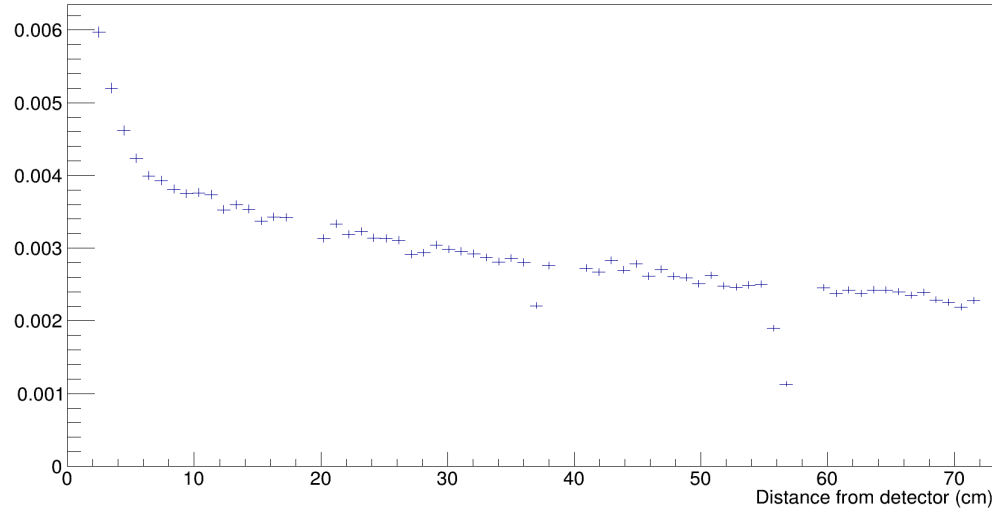
Verification

- Comparison of double shift light guide simulation to Howard et al
- Floating TPB plates over EJ-280 bar



Verification

Detection Efficiency



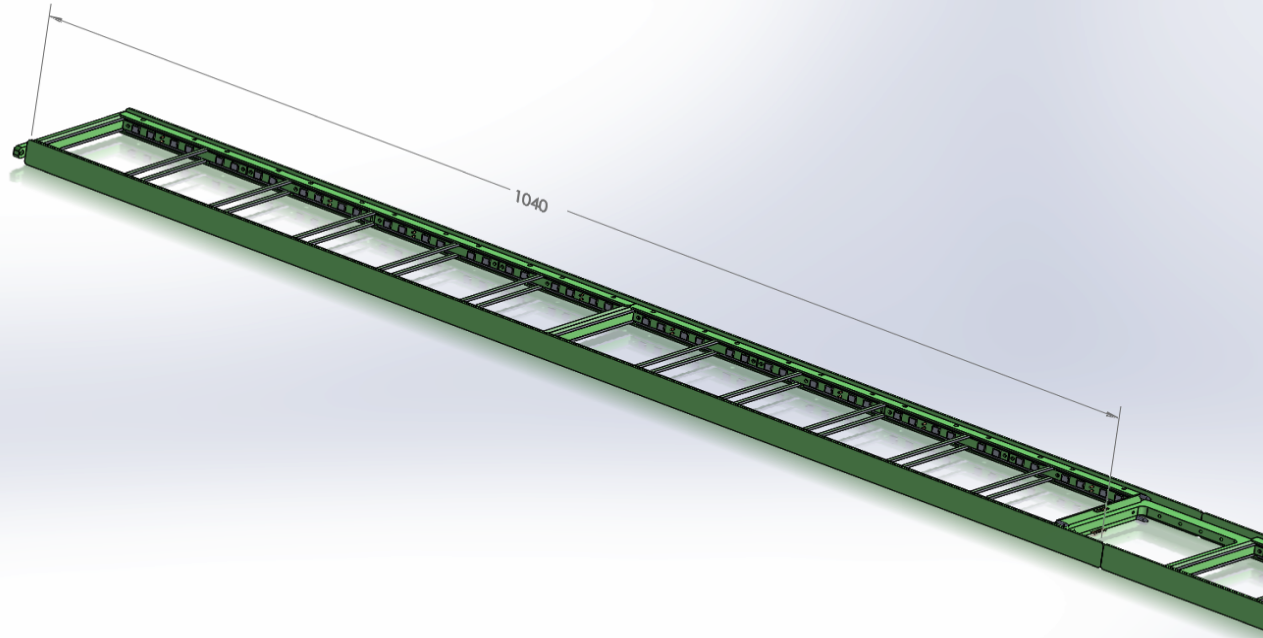
The Syracuse simulation does not account for efficiency differences in each of the TPB layers, so the simulation assumes the measured quantum efficiency of the first bar from Howard et al for all TPB layers.



Current Status

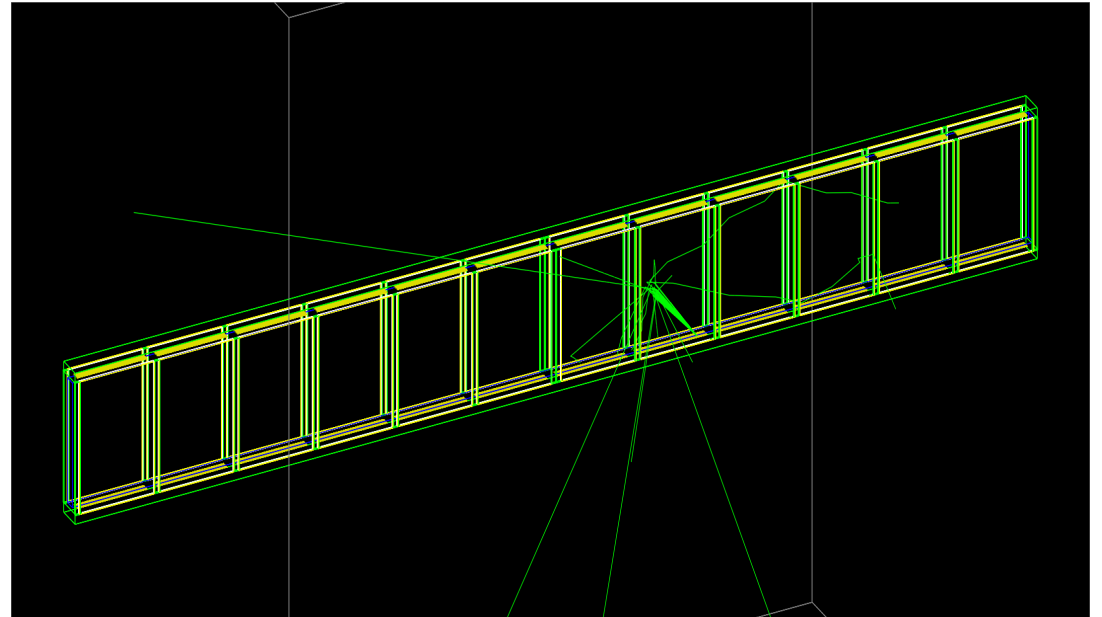
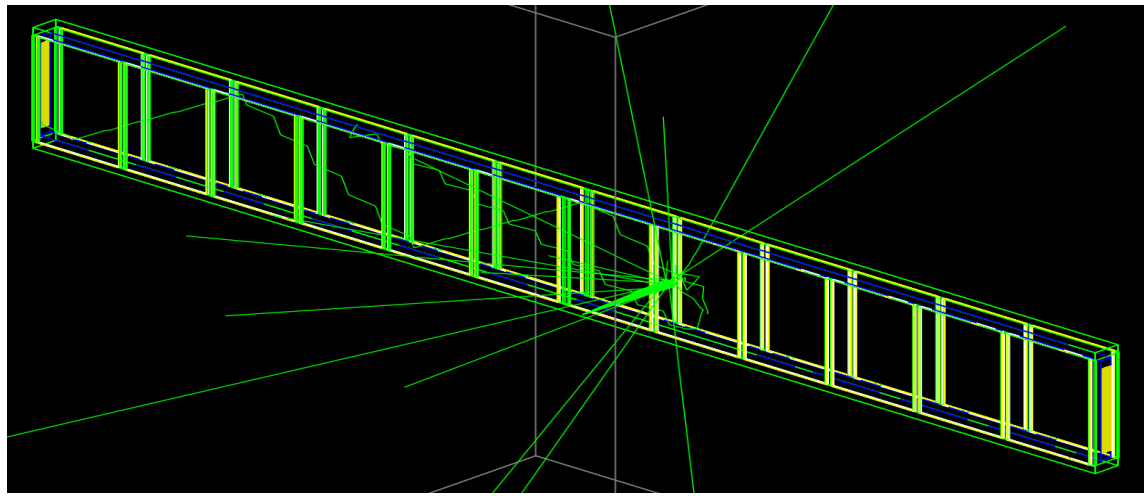
- Full Double Shift Light Guide module geometry defined
 - Two configurations- Detectors on ends vs sides
 - Preliminary simulations- first efficiency measurements made
- Working to implement dichroic filter
 - Working implementation, no tests performed

Current Status



CAD drawing of the light
guide frame from David
Warner (CSU)

Detectors on both ends



Detectors down both sides



Future

- Perform two dimensional scans of all geometries
- Create simulation of ARAPUCA detector design for comparison
- Perform full comparison of efficiencies for all current design options

